Mrs. Meer
Honors Chemistry

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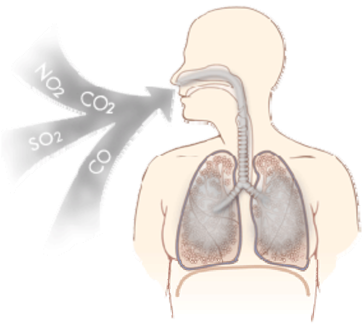
Date_______________ Period______



Gases

Chapter 11

<u>Text Reference:</u> Page 360-399
Section 1: Gases and Pressure
Section 2: The Gas Laws
Section 3: Gas Volumes and the Ideal Gas Law
Section 4: Diffusion and Effusion

<u>Concept Base:</u>

- states and physical properties of matter, Chapter 1
- scientific notation and significant figures, Chapter 2
- writing and balancing chemical equations, Chapter 8
- stoichiometric calculations, Chapter 9
- the relationship between temperature and particle motion, Chapter 10

My Checklist:

- ☐ Read Section 1, pages 360-368
- ☐ Read Section 2, pages 369-377
- ☐ Read Section 3, pages 378-385
- ☐ Read Section 4, pages 386-388
- ☐ Do Self-Check Quiz for Section 1
- ☐ Do Self-Check Quiz for Section 2
- ☐ Do Self-Check Quiz for Section 3
- ☐ Do Self-Check Quiz for Section 4
- ☐ Look at Visual Concepts for Section 1
- ☐ Look at Visual Concepts for Section 2
- ☐ Look at Visual Concepts for Section 3
- ☐ Look at Visual Concepts for Section 4
- ☐ Review Chapter Highlights on page 389

My Summary of the Gas Laws

(You are to take your own notes for each law.)

Dalton's Law of Partial Pressure

Boyle's Law

Charles' Law

Combined Gas Law

Gay-Lussac's Law

Avogadro's Law

Ideal Gas Law

Graham's Law of Diffusion

Section 1: Gases and Pressure

Pressure

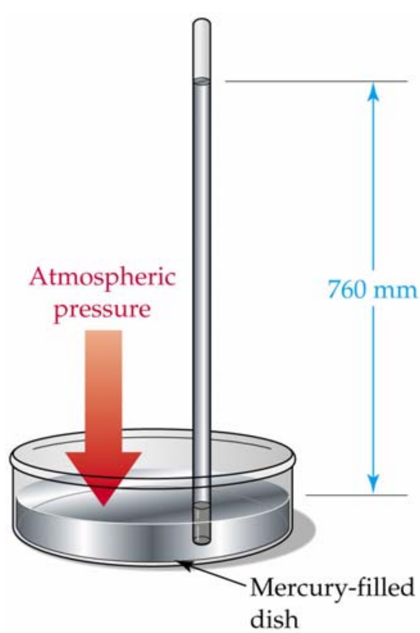
$$P = \frac{F}{A}$$

standard pressure – the pressure exerted at sea level in dry air
1.00 atm
760. mmHg
760. torr
101.325 kPa
1.01325×10^5 N/m^2 (Pa)
14.7 psi
29.9 inHg

Example 1: Convert 723 mmHg to kPa.

Example 2: Convert 100. kPa to atm.

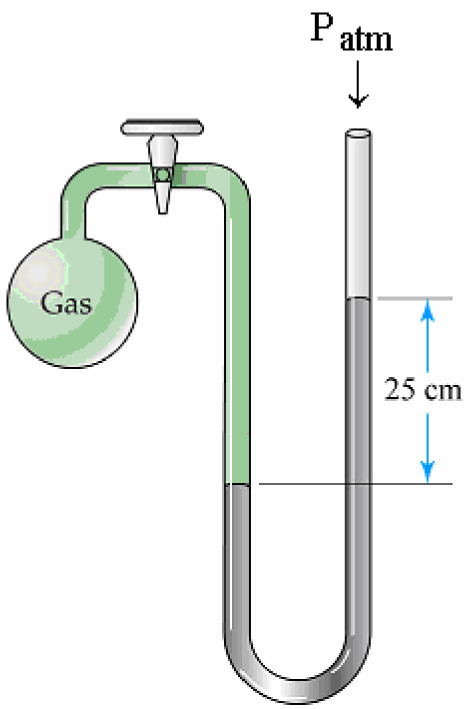
barometer – a device used for measuring the pressure of the atmosphere



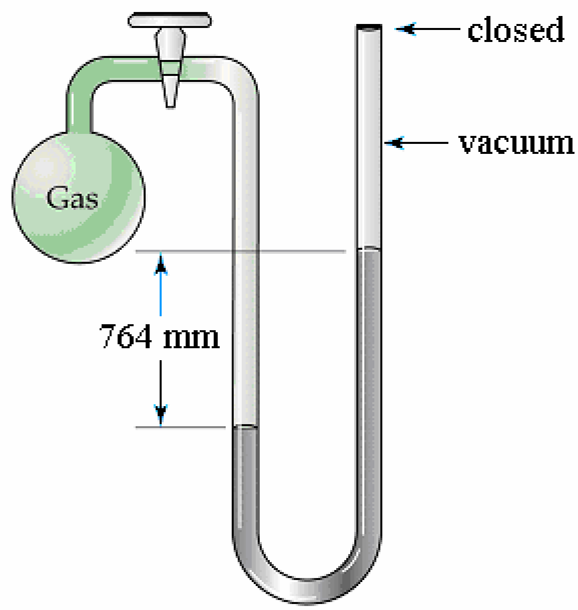
How does a barometer work?

Gas Pressure

manometer – a device used for measuring the pressure of a gas in a container



open-ended manometer

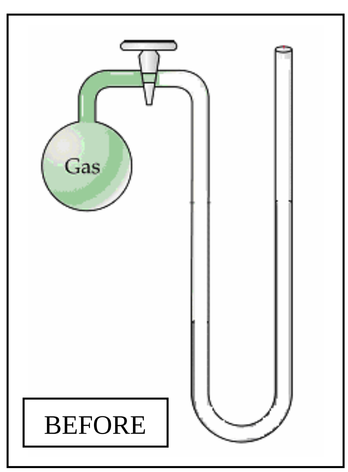


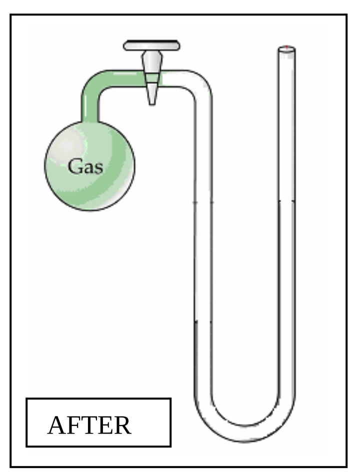
closed-ended manometer

How does a manometer work?

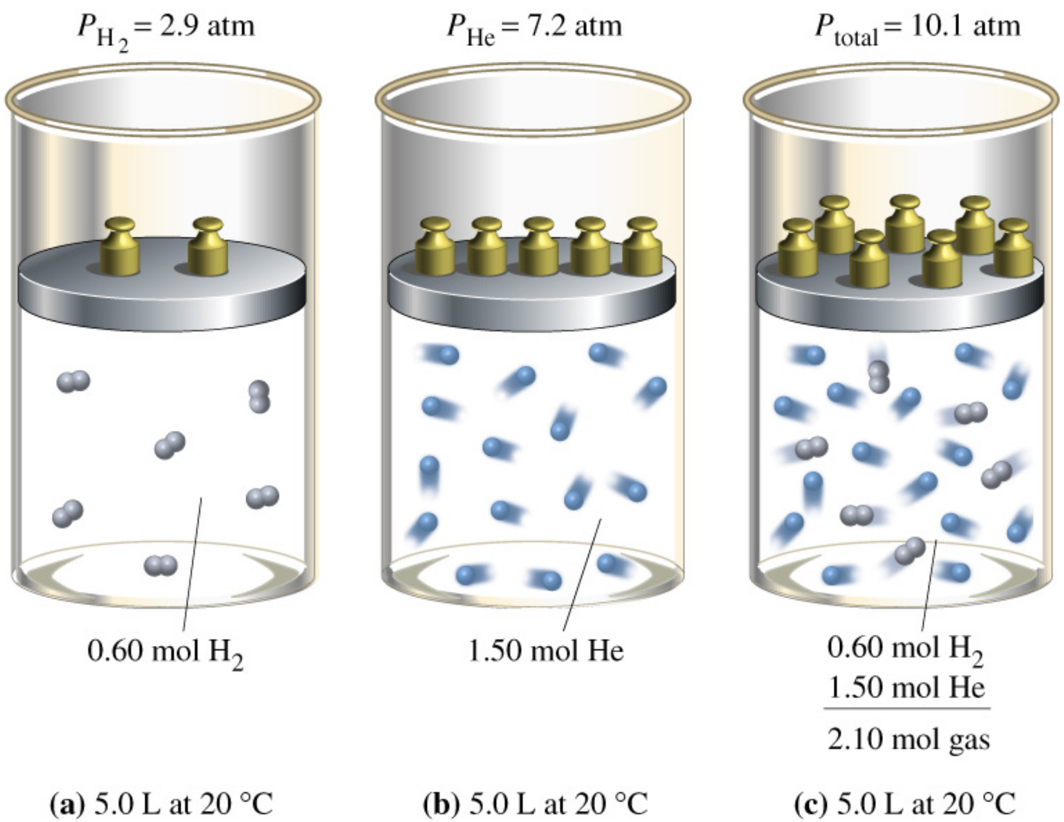
Example 3: An open-ended manometer is attached to a flask of gas that is exerting a pressure of 104.5 kPa. The atmospheric pressure is 99.8 kPa. (Notice the pressures are in kPa, not mmHg.)

A. Fill in the picture of the manometer with the mercury levels before the stopcock is opened.
B. When the flask is attached, will the mercury in the open arm of the U-tube move up or down?
C. Fill in the picture of the manometer with the mercury levels after the stopcock is opened.





Dalton's Law of Partial Pressures



The pressure of each gas in a mixture is called the *partial pressure* of that gas.

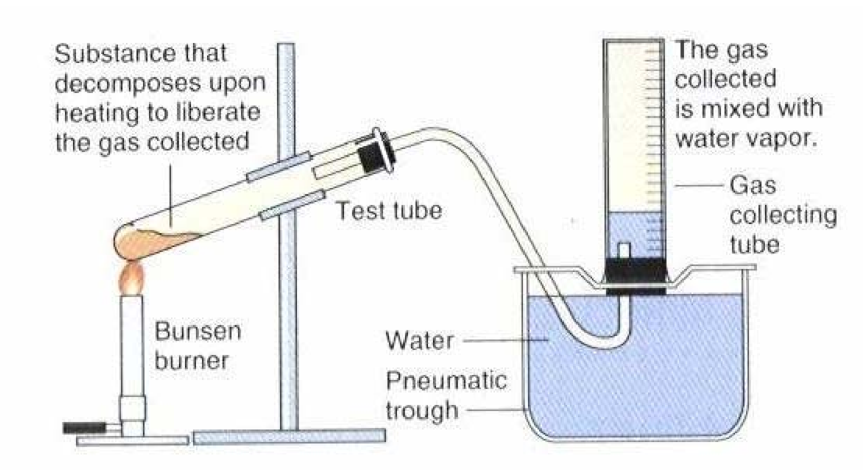
Dalton's law of partial pressures states that the total pressure of a gas mixture is the sum of the partial pressures of the component gases.

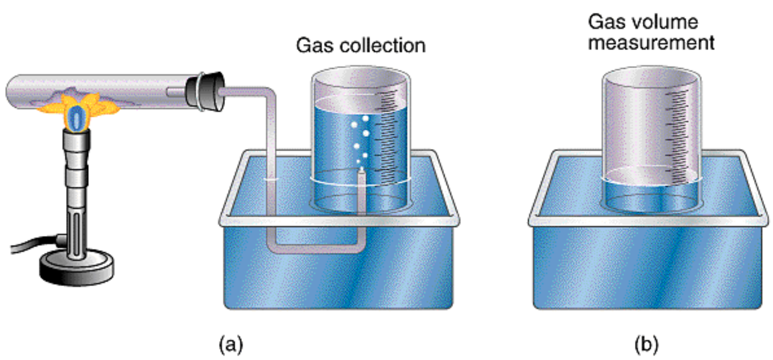
$$P_T = P_1 + P_2 + P_3 + \ldots$$

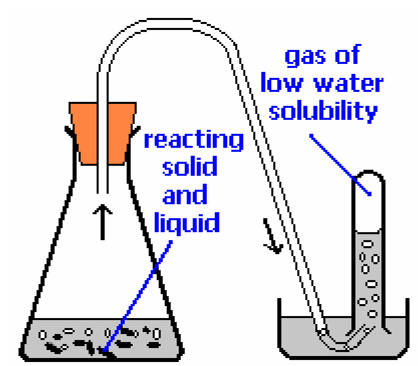
If a gas is collected by water displacement, then the total pressure is due to the collected gas and the water vapor.

$$P_T = P_{gas} + P_{H_2O}$$

Gas Collection Over Water – Water Displacement







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Dalton's Law of Partial Pressures

1. What is the atmospheric pressure if the partial pressures of nitrogen, oxygen, and argon are 604.5 mmHg, 162.8 mmHg, and 0.5 mmHg, respectively?

2. What percent is nitrogen, what percent is oxygen, and what percent is argon, according to the data in Question 1?

3. A person using an oxygen mask is breathing air with 33% oxygen. What is the partial pressure of the O_2 when the air pressure in the mask is 110 kPa?

Table of Vapor Pressure of Water (H_2O)

Temperature °C	Pressure kPa		Temperature °C	Pressure kPa		Temperature °C	Pressure kPa
0	0.6		20	2.3		30	4.2
3	0.8		21	2.5		32	4.8
5	0.9		22	2.6		35	5.6
8	1.1		23	2.8		40	7.4
10	1.2		24	3.0		50	12.3
12	1.4		25	3.2		60	19.9
14	1.6		26	3.4		70	31.2
16	1.8		27	3.6		80	47.3
18	2.1		28	3.8		90	70.1
19	2.2		29	4.0		100	101.3

4. A 250. mL sample of oxygen is collected over water at 25°C and 101.325 kPa pressure. What is the pressure, in kPa, of the dry gas alone?

5. A 32.0 mL sample of hydrogen gas is collected by water displacement at 20.°C and 750.0 torr pressure. What is the pressure of the dry gas alone?

6. A mixture of 2.00 moles of H_2, 3.00 moles of NH_3, 4.00 moles of CO_2 and 5.00 moles of N_2 exerts a total pressure of 800.0 mmHg. What is the partial pressure of each gas?

APPLICATIONS OF CHEMISTRY

The Loch Ness Monster and Boyle's Law

The Loch Ness Monster has been an object of curiosity since A.D. 565 (see photo at right). In that year St. Columba, while on a mission to convert Scotland to Christianity, first reported seeing the Loch Ness Monster. Thousands of other people have also reported seeing the Loch Ness Monster.

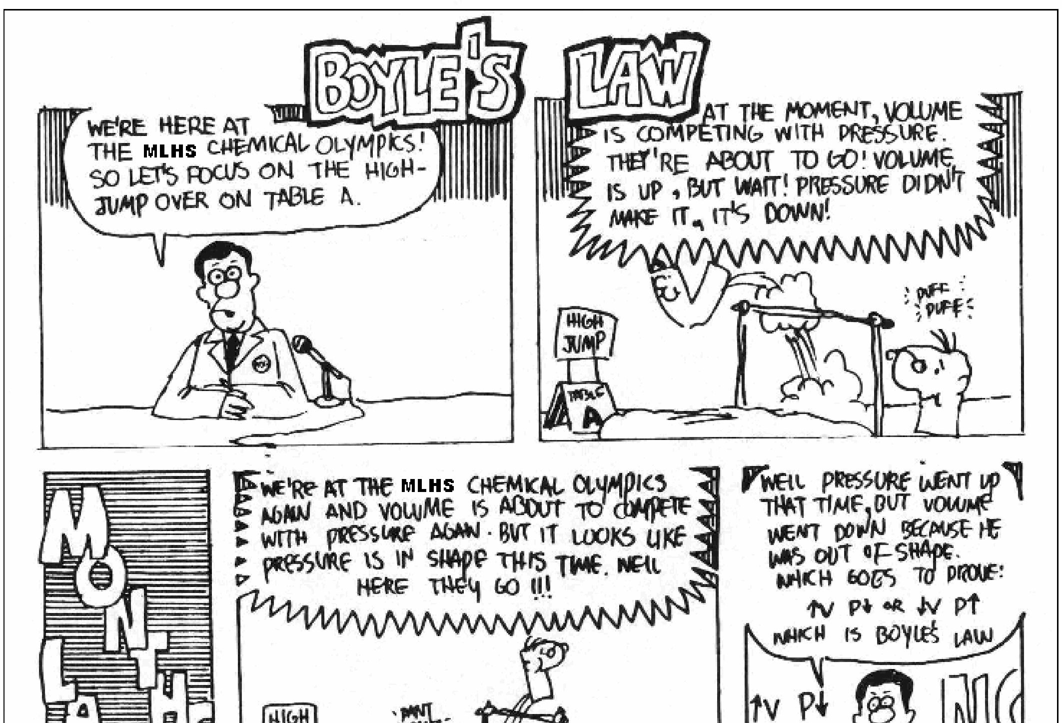
The scientific community began to take these sightings somewhat seriously as the reported sightings continued. In 1972, a team led by MIT physics graduate Robert Rines searched for the monster. A year later, Japanese scientists funded a $500,000 Loch Ness Monster expedition, and the *New York Times* sponsored another search in 1976. Scientists conducted a $1.6 million investigation in 1987.

Monsters have been seen in three of the 500 freshwater lochs (lakes) in Scotland. These three lakes are very deep, and each is surrounded by Scotch pines, which are not present around the other lakes. These facts suggest the following theory.

Scotch pines have much more resin than other pines. If you have ever had a Scotch pine Christmas tree, you probably noticed that the presents under the tree become covered with sap. When a Scotch pine dies and falls into a lake, it sinks to the bottom and the wood releases its resin. The resin, clinging to the dead tree, traps decomposition gases from the decaying wood. Trapped by the resin, the gases form blisters on the tree. As the blisters increase in size, they become large enough to buoy the tree to the surface. Since water pressure is greater on the bottom of the loch than at the top, the pressure on the blisters decreases continuously as the tree rises to the top. Boyle's law tells us that as gas pressure decreases, its volume increases. So as the tree rises, the blisters continue to inflate. The more the blisters inflate, the greater the buoyant force becomes, and as the buoyancy increases, the tree rises faster and faster. Eventually, the blisters burst and the tree sinks quickly back to the bottom of the loch. Every once in a while, a tree reaches the surface, where it raises its "monster-like" head out of the water before quickly diving again out of sight.

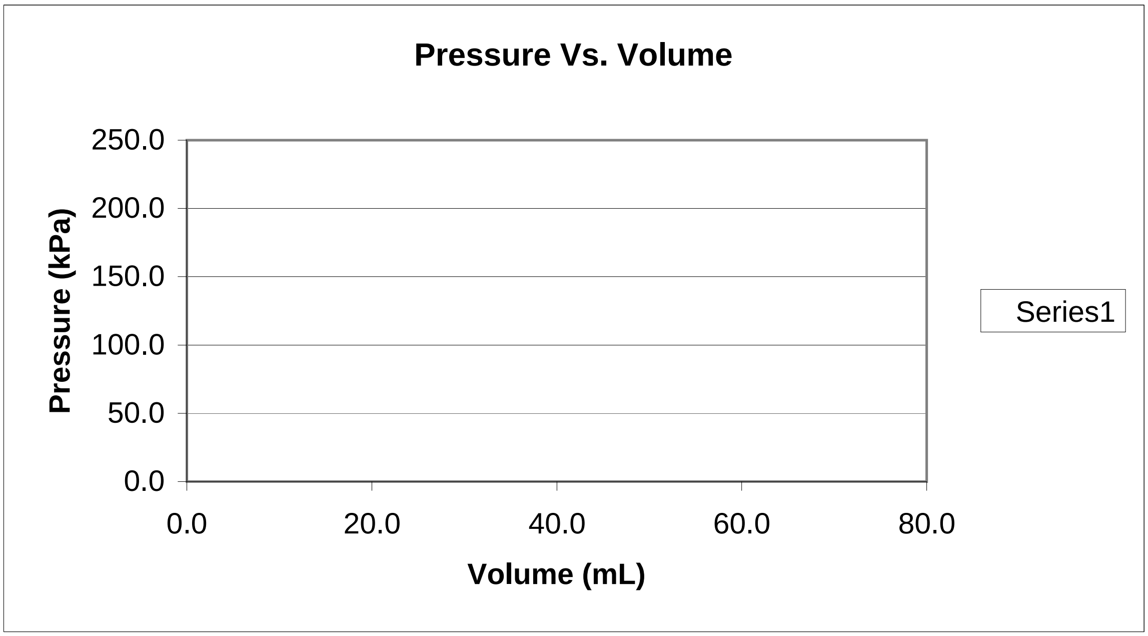
Scientists have shown that about 80 percent of the monster sightings occurred during surface temperature inversions. A surface temperature inversion exists when the temperature of a layer of air increases with altitude. Temperature inversions produce atmospheric image distortions, and these distortions can make protruding trees appear to move, grow, shrink, curve back, and expand vertically.

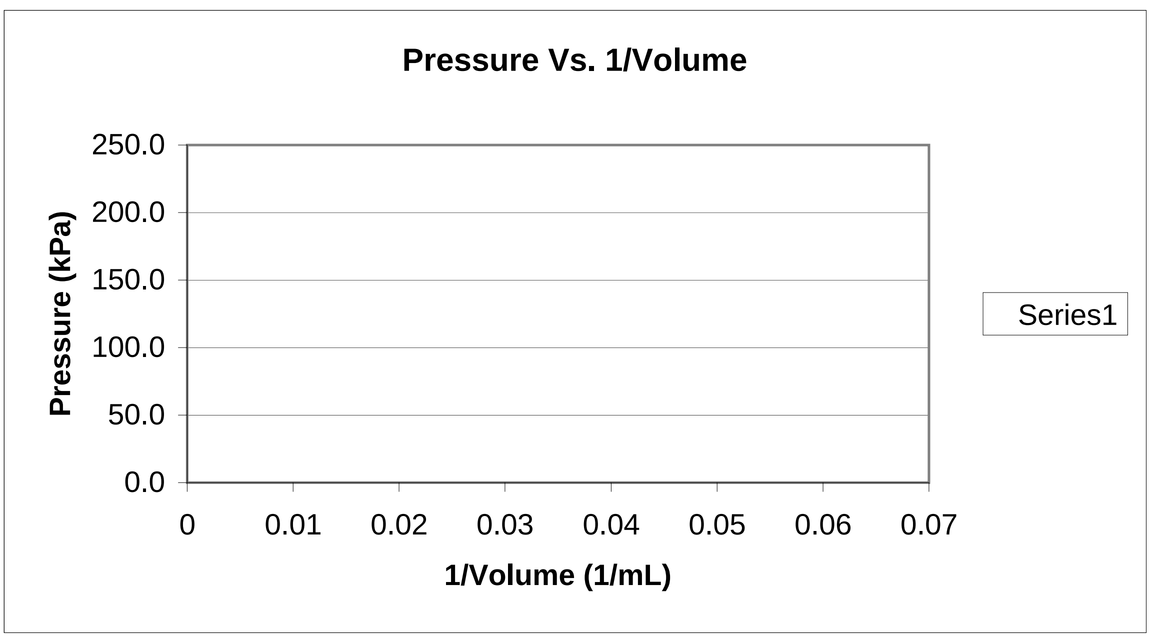
Source: Ronald De Lorenzo, *Journal of Chemical Education*, July 1989, page 570.



Boyle's Law: The Relationship between Pressure and Volume.

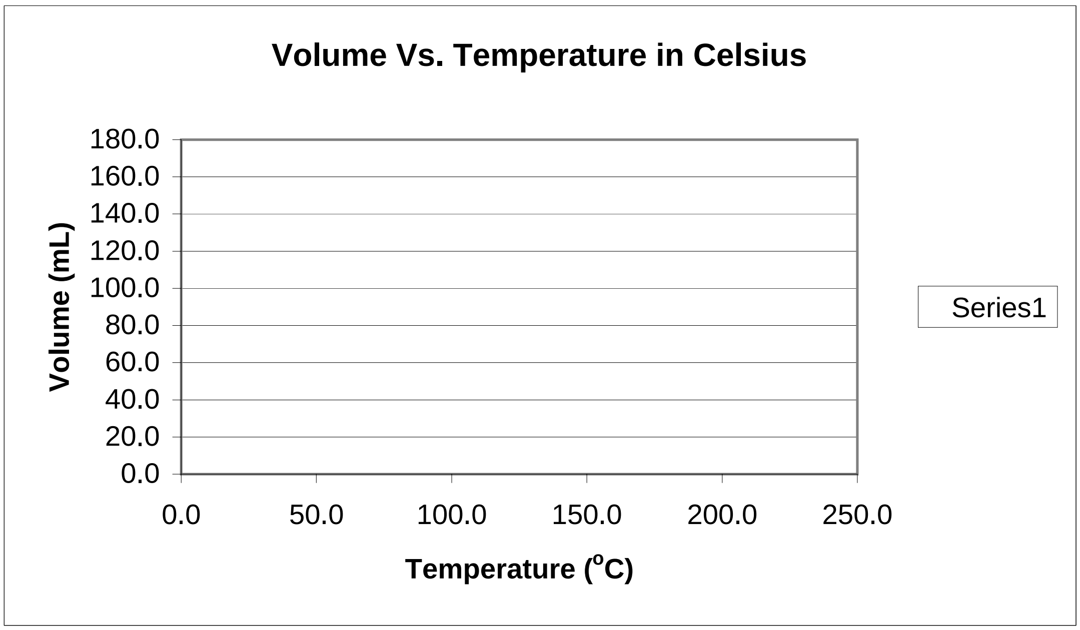
Volume (mL)	Pressure (kPa)	P x V	1/V (1/mL)	Pressure (kPa)
75.0	44.5	3337.5	0.0133333	44.5
60.0	55.6	3336.0	0.0166667	55.6
45.0	74.1	3334.5	0.0222222	74.1
30.0	111.2	3336.0	0.0333333	111.2
15.0	222.3	3334.5	0.0666667	222.3

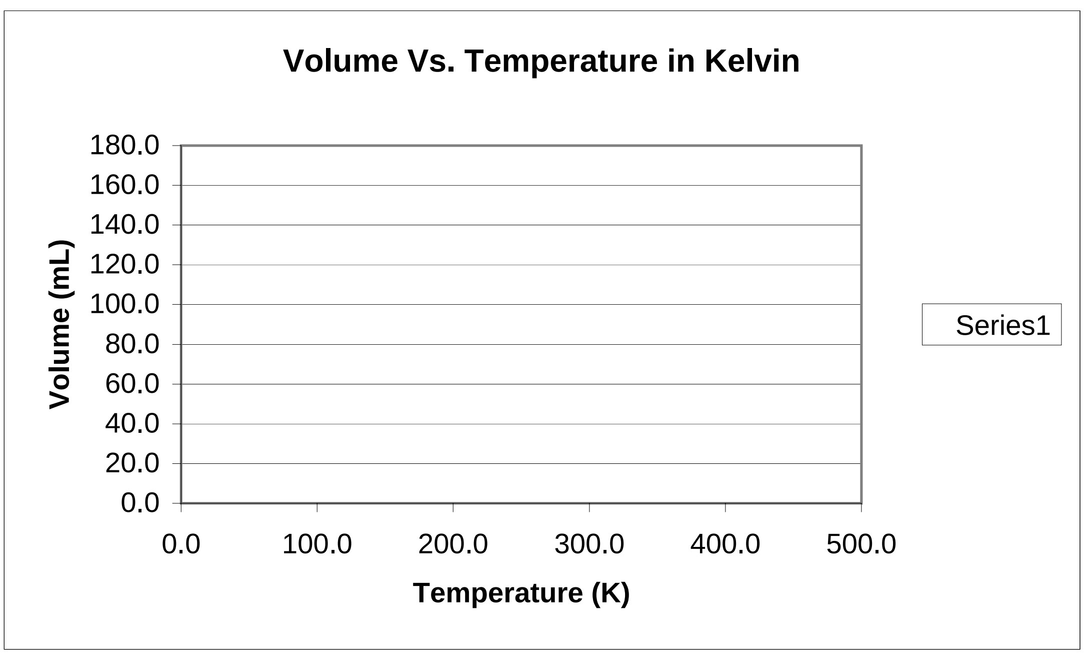




Charles' Law: The Relationship between Volume and Temperature.

T (°C)	V (mL)	T (K)	V (mL)	V / T (K)
10.0	100.0	283.0	100.0	0.353357
50.0	114.0	323.0	114.0	0.352941
100.0	132.0	373.0	132.0	0.353887
200.0	167.0	473.0	167.0	0.353066





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$P_1V_1 = P_2V_2$

Boyle's Law and Charles' Law

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

- Solve each problem and answer all questions.
- In the blank to the left of the problem, state whether it is Boyle's Law or Charles' Law.
- For each problem, assume all else is held constant. The only things changing are what is in the problem.

________________ **1a.** A 2.0 L container of nitrogen had a pressure of 3.2 atm. What volume would be necessary to decrease the pressure to 1.00 atm?

1b. Does the volume go up or down with a decrease in pressure? ________________
1c. What type of relationship does this represent? ____

1d. What three things do you have to assume for your answer to 1a to be correct? __________________
____

________________ **2a.** A sample of carbon dioxide occupies a volume of 3.50 L at 125 kPa of pressure. What pressure in kPa would the gas exert if the volume was decreased to 2.00 L?

2b. Does the pressure go up or down with a decrease in volume? ________________
2c. What type of relationship does this represent? ____

________________ **3a.** Fluorine gas exerts a pressure of 900. torr. When the pressure is changed to 1.50 atm, its volume is 250. mL. What was the original volume in mL?

3b. Does the volume go up or down with an increase in pressure? ________________
3c. What type of relationship does this represent? ____

_______________ **4a.** Hydrogen gas was cooled from 150. ^{o}C to 50. ^{o}C. Its new volume is 75 mL. What was its original volume in mL?

4b. Does the volume go up or down with a decrease in temperature? _______________
4c. What type of relationship does this represent? ____

_______________ **5a.** A sample of argon gas was cooled and its volume went from 380. mL to 250. mL. If its final temperature was -55 ^{o}C, what was its original temperature in Celsius?

5b. Does the temperature go up or down with a decrease in volume? _______________
5c. What type of relationship does this represent? ____

_______________ **6.** On a cool morning (10.0^{o}C) a group of hot-air balloonists start filling their balloon with air, using a large fan. After the balloon's envelope is three-fourths filled, they turn on the propane burner to heat the air. At what Celsius temperature will the air completely fill the envelope to its maximum capacity of 1700. m^3? (You many assume the pressure is constant and that no air escapes from the balloon while it is being heated.)

_______________ **7.** A sample of Freon gas used in an old air conditioner has a volume of 325 L and a pressure of 96.3 kPa at 20^{o}C. What will the pressure in kPa of the gas be when its volume is 975 L at 20^{o}C?

_______________ **8.** A sample of carbon dioxide occupies 300. mL at 10. ^{o}C and 750. torr. What volume in mL will the gas have at 30. ^{o}C and 750. torr?

_______________ **9.** A 2.50 L volume of hydrogen measured at the normal boiling point of nitrogen is warmed to the normal boiling point of water and expands to become 12.1 L. Calculate the normal boiling point of nitrogen in Celsius.

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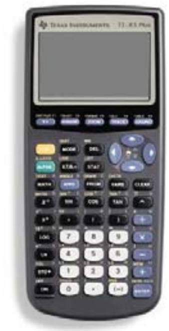
Gas Laws Worksheet



1. If a sample of nitrogen gas has an initial pressure of 720. torr, an initial volume of 256 mL, and an initial temperature of 25^oC, what is its final pressure if the volume is changed to 250. mL and the temperature is changed to 50.^oC?

2. A sample of oxygen gas has an initial pressure of 850. mmHg, an initial volume of 1.5 L, and an initial temperature of 15^oC. What is its new volume if the pressure is changed to 810. mmHg and the temperature is changed to 30.^oC?

3. A sample of argon gas has an initial pressure of 95 kPa and initial volume of 4.00 L. The pressure is changed to 101 kPa, the volume is changed to 6.00 L, and the temperature is changed to 198^oC. What is the initial temperature in Celsius?

4. The final pressure, temperature, and volume of a gas sample is 2.0 atm, 25^oC, and 515 mL, respectively. What is the original volume of the gas if the original temperature and pressure were standard temperature and pressure (STP)?

5. If a given sample of gas occupies 8.6 L at 327 ^oC, what will be its volume at 27^oC if the pressure does not change?

6. A gas mixture containing oxygen, nitrogen, and carbon dioxide has a pressure of 250. mmHg. If the oxygen exerts a pressure of 50.0 mmHg and the nitrogen exerts a pressure of 175.0 mmHg, then what is the pressure due to the carbon dioxide?

7. A 5.00 L sample of air at -50.0^{o}C is warmed to 100.0^{o}C. What is the new volume if the pressure and moles remain constant?

8. A gas with a volume of 4.0 L at a pressure of 0.90 atm is allowed to expand until the new volume is 5.5 L. What is the new pressure, assuming the temperature and moles are held constant?

9. A 5.50 L air sample is at STP. What is the new temperature in Celsius if the volume is expanded to 6.50 L and the pressure is lowered to 99.5 kPa?

10. A given mass of air has a volume of 6.0 L at 1.00 atm. What volume, in liters, will it occupy at 190. mmHg if the temperature does not change?

11. A “tennis ball saver” is a cylindrical device that keeps tennis balls under pressure to maintain their bounce longer. When open, this device has a volume of 36.0 in^3. When closed and pressurized, the volume is decreased to 18.2 in^3. Assuming 1.00 atm pressure when the device is open, what is the pressure inside when it is closed? Assume no temperature change during the pressurizing process.

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Collected Over Water

Table of Vapor Pressure of Water (H_2O)							
Temperature °C	**Pressure kPa**		**Temperature °C**	**Pressure kPa**		**Temperature °C**	**Pressure kPa**
0	0.6		20	2.3		30	4.2
3	0.8		21	2.5		32	4.8
5	0.9		22	2.6		35	5.6
8	1.1		23	2.8		40	7.4
10	1.2		24	3.0		50	12.3
12	1.4		25	3.2		60	19.9
14	1.6		26	3.4		70	31.2
16	1.8		27	3.6		80	47.3
18	2.1		28	3.8		90	70.1
19	2.2		29	4.0		100	101.3

1. A 250. mL sample of oxygen is collected over water at 30.°C and 101.3 kPa pressure. What is the pressure, in kPa, of the dry gas alone?

2. A 100.0 mL sample of oxygen is collected over water at 25 °C and a pressure of 110. kPa. What is the volume of the dry gas at the new conditions of STP?

3. A 32.0 mL sample of hydrogen is collected over water at 20.°C and 750.0 torr pressure. What is the volume of the dry gas at STP?

4. A 54.0 mL sample of oxygen is collected over water at 23°C and 770.0 torr pressure. What is the volume of the dry gas at STP?

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I love the gas laws!

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Gay-Lussac's Law

In 1802, a scientist named Joseph Gay-Lussac (1778-1850) recognized that for every Kelvin of temperature change, the pressure of a confined gas changes by $\frac{1}{273}$ of the pressure at 0^{o}C. As another interesting note, in 1804, Joseph Louis Gay-Lussac broached 20,000 feet in a hot-air balloon and became the first human to recognize the effects of altitude-induced oxygen starvation.

Gay-Lussac's law: The pressure of a fixed mass of gas at constant volume varies directly with the Kelvin temperature.

$$P \propto T$$

$$P = kT$$

$$\frac{P}{T} = k$$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

T must be in Kelvin!

1. A sample of helium gas has a volume of 100.0 mL. Its pressure is 0.960 atm at 25 ^{o}C. What is its pressure at a temperature of 35^{o}C? Ans: 0.992 atm

2. 5.6 g of oxygen gas has a pressure of 765 torr at 22 ^{o}C. What is the new temperature in Celsius of the gas if the pressure is changed to 780. torr? Ans: 28 ^{o}C

3. Have you ever noticed that an aerosol spray can gets cold when you spray the gas out of the can? Guy-Lussac's Law supports the idea that as the pressure decreases, so does the temperature. A sample of gas at a pressure of 1.05 atm (high pressure) and a temperature of 22 ^{o}C (room temperature) is released out of a can. The new pressure is standard pressure. What is the new temperature of the gas in Celsius? Ans: 8^{o}C

Notes: Ideal Gas Law

What does it mean to be an "ideal gas"?

What is Charles' Law?

What is Boyle's Law?

What is Avogadro's Law?

Equal volumes of gases at the same T & P have the same number of molecules.

Therefore, if the number of molecules doubles, ____.

Therefore, if the number of moles (n) doubles, ____.

Therefore,

How do you change a proportion into an equality?

Take these three laws, $\frac{V}{T} = k$ $PV = k$ $\frac{V}{n} = k$ and combine:

PV = nRT	where	P = pressure V = volume in liters n = number of moles of gas R = Ideal Gas Constant T = temperature in Kelvin

Depending on what unit the pressure is reported, you will choose one of the three R values: (so the units cancel)

$R = 0.0821 \frac{L \bullet atm}{mol \bullet K}$ $R = 8.31 \frac{L \bullet kPa}{mol \bullet K}$ $R = 62.4 \frac{L \bullet mmHg}{mol \bullet K}$

Example: Calculate the pressure of 1.65g of helium gas at 16.0^{o}C, occupying a volume of 3.25 L.

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Ideal Gas Law (& More) Worksheet

Oh, the Gas Laws are good to know,
You can use 'em everywhere you go
We're talking heavy-duty chemistry.
We're talking PV=nRT.

1. What is the pressure, in atmospheres, exerted by a 0.500 mol sample of nitrogen in a 10.0 L container at 25.0^oC?

2. What is the volume occupied by 0.250 mol of oxygen at 20.0^oC and 740.0 mmHg pressure?

3. What pressure, in atmospheres, is exerted by 0.6565 g of hydrogen gas in a 4.08 L container at 35.0^oC?

4. A sample of hydrogen gas has a volume of 8560. mL at standard temperature and a pressure of 1.50 atm. Calculate the number of moles of H_2 present in this gas sample.

5. A hydrogen-filled balloon has a volume of 3.20 L at 752 torr and 30.^oC. When allowed to an altitude where the pressure of the gas is 715 torr, the balloon has the volume of 3.32 L. What is the temperature at that altitude in Celsius?

6. What mass of chlorine, in grams, is contained in a 100.0 mL tank at 27.0^oC and 2660. mmHg of pressure?

7. At what temperature (^oC) will a 10.00 g sample of neon gas exert a pressure of 96.7 kPa in a 9.50 L container?

8. What is the mass, in grams, of oxygen in a 12.5 L container at 45.0^oC and 7.22 atm?

9. What is the volume of 1.00 mole of carbon dioxide at standard temperature and pressure?

10. A given mass of air at a given temperature has a volume of 6.0 L at 1.0 atm. What pressure in mmHg will it have if the volume is 24.0 L?

11. If a given sample of gas occupies 8.60 L at 327^oC, what will be its temperature (^oC) if it has a volume of 8.00 L if the pressure does not change?

12. Calculate the temperature in Kelvin to which 200. mL of a gas at 273 K and 750 torr must be heated to increase the volume to 250. mL at 740 torr.

13. What is the total pressure in atmospheres of a gaseous mixture containing 1.00 g of He, 2.00 g of H_2, and 3.00 g N_2 in a 10.0 L container at 300 K?

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Graham's Law of Effusion/Diffusion

- *diffusion* – the spontaneous movement of particles of gas caused by random motion (high concentration to low concentration)
- *effusion* – process by which gas particles pass through a tiny opening due to pressure being exerted upon them

Graham's Law – A gas will effuse at a rate that is inversely proportional to the square root of its molar mass, M. Expressed mathematically, it is:

$$\frac{rate_1}{rate_2} = \sqrt{\frac{M_2}{M_1}}$$

"Lighter molecules move faster than heavier molecules at the same temperature."

If the gases are at the same T, and $T \propto KE$, then they are at the same KE.

$$KE_1 = KE_2$$
$$\frac{1}{2}m_1 v_1^2 = \frac{1}{2}m_2 v_2^2$$
$$m_1 v_1^2 = m_2 v_2^2$$
$$\frac{v_1^2}{v_2^2} = \frac{m_2}{m_1}$$
$$\frac{v_1}{v_2} = \sqrt{\frac{m_2}{m_1}}$$

This is from where the equation comes!

1. Which gas moves faster across the room, NH_3 or He? Why?

2. What is the relative rate of diffusion of NH_3 compared to He?

3. Under the same conditions of temperature and pressure, how many times faster will hydrogen effuse compared to carbon dioxide?

4. An unknown gas diffuses 0.25 times as fast as He. What is the molar mass and name of the unknown gas?

5. The rate of diffusion of an unknown gas is 4.0 times faster than the rate of oxygen gas. What is the molar mass and name of the unknown gas?

6. Ammonia, NH_3, and alcohol, C_2H_6O, are released together across a room. Which will you smell first? Why?

7. At a certain temperature and pressure, chlorine molecules have an average velocity of 324 m/s. What is the average velocity of sulfur dioxide molecules under the same conditions? Ans: 341 m/s

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Gas Stoichiometry Worksheet

1. Calculate the volume of oxygen gas produced at 1.00 atm and 25°C by the complete decomposition of 10.5 g of potassium chlorate. $2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$

2. Calculate the volume of hydrogen produced at 1.50 atm and 19°C by the reaction of 26.5 g of zinc with excess hydrochloric acid. $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

3. Water is decomposed to produce hydrogen gas and oxygen gas. What would be the pressure, in atmospheres, of a 4.5 g sample of hydrogen gas with a volume of 1.2 L and a temperature of 22°C?

4. Quicklime, CaO, is produced by heating calcium carbonate, $CaCO_3$. Calculate the volume of CO_2 produced at STP from the decomposition of 152 g of $CaCO_3$ according to the reaction,

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

5. Using the equation in the previous problem, what volume of carbon dioxide gas is produced at 25°C and a pressure of 1.02 atm when 10.0 g of calcium carbonate is decomposed?

6. What volume of oxygen gas, measured at 31°C and 745 mmHg is needed to burn 5.00 g of benzene, C_6H_6?

Challenge: When 24.0 g of ethanol, C_2H_5OH, is burned with 9.00 g of oxygen, what volume of carbon dioxide gas, measured at 35°C and 0.95 atm, would be produced?

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Chemistry

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Density and Molar Mass

$$D = \frac{g}{V}$$

$$\text{molar mass} = \frac{g}{mol}$$

1. What mass of nitrosyl chloride, NOCl, occupies a volume of 0.250 L at a temperature of 325 K and a pressure of 113.0 kPa?

2. What is the density of NOCl under these conditions?

3. A sample of phosphorus that weighs 3.242×10^{-2} g exerts a pressure of 31.89 kPa in a 56.0 mL bulb at 550^{o}C. What are the molar mass and molecular formula of phosphorus vapor?

4. What is the density of ethane gas, C_2H_6, at a pressure of 183.4 kPa and a temperature of 25^{o}C?

5. Calculate the density of fluorine gas, F_2, at STP.

6. The density of a certain gaseous fluoride of phosphorus is 3.93 g/L at STP. Calculate the molar mass of this fluoride, and determine its molecular formula.

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REVIEW PROBLEMS – PART I

1. If the barometer at your house reads 768.2 mmHg, what is the atmospheric pressure in kPa?

2. The gas in a manometer has a pressure of 750.0 mmHg. If the height of the mercury is 6.0 mm higher on the open end of the tube, what is the atmospheric pressure in atm?

3. When a cylinder of oxygen is left standing in the sun, the temperature of the gas reaches 42^{o}C. The cylinder has a volume of 10.0 L and contains 128 g of oxygen. What is the pressure in atmospheres inside the cylinder?

4. Seaweed plants release oxygen gas during photosynthesis. A 0.10 cm^{3} bubble is released underwater at a pressure of 176 kPa and a temperature of 10.^{o}C. What volume will this bubble occupy at the surface, where the temperature is 15^{o}C and the pressure is 1.00 atm?

5. Sulfur dioxide has a density of 2.927 g/L at STP. What is its density at a pressure of 108 kPa and 50.0^{o}C?

6. A certain balloon will burst at any volume above three liters. It is partially filled (2.4 L) at a temperature of 22 ^{o}C. If the pressure remains constant, to what maximum temperature can it be heated before it bursts?

7. A room is a cube that measures 4 meters in each dimension. If the temperature changes from 10.^{o}C to 30.^{o}C, and the pressure decreases from 760. torr to 718 torr, would air be trying to enter or leave the room? Explain.

8. What would the density of 1.0 L of hydrogen gas be at STP?

9. When two cotton plugs, one moistened with ammonia and the other with hydrochloric acid, are simultaneously inserted into opposite ends of a glass tube 87.0 cm long, a white ring of NH_4Cl forms where gaseous NH_3 and gaseous HCl first come into contact. $NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$
At what distance from the ammonia-moistened plug does this occur?

Challenge: One mole of hemoglobin molecules will combine with four moles of oxygen molecules. If 1.0 g of hemoglobin combines with 1.53 mL of oxygen at body temperature (37^{o}C) and a pressure of 743 torr, what is the molar mass of hemoglobin?

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Review Problems – Part II

1. A sample of argon gas has an initial pressure of 95 kPa and an initial volume of 4.0 L. The pressure is changed to 101 kPa, the volume is changed to 6.0 L, and the temperature is changed to 198^{o}C. What is the initial temperature in Celsius?

2. A 54.0 mL sample of oxygen is collected over water at 23^{o}C and 770.0 torr pressure. What is the volume of the dry gas at STP? (Vapor pressure of water at 23^{o}C = 21.1 torr)

3. The partial pressure of F_2 in a mixture f gases where the total pressure is 1.00 atm is 300. torr. If the total sample is 10.0 moles, how many moles of F_2 are there?

4. Mathematically, give the relative rates of diffusion of oxygen to hydrogen. Now turn this mathematical answer into a verbal statement regarding their rates of diffusion.

5. An unknown gas diffuses 0.2132 times as fast as H_2. What is the molecular mass of the unknown gas, and what gas is it?

6. If a given sample of gas occupies 10.6 L at 327^{o}C, what will be its volume at 27^{o}C if the pressure does not change?

7. A gas with a volume of 4.5 L at a pressure of 0.90 atm is allowed to expand until the pressure drops to 0.20 atm. What is the new volume, assuming the temperature and moles are held constant?

8. At what temperature will a 10.0 g sample of neon gas exert a pressure of 66.7 kPa in a 5.00 L container?

9. A sample of argon gas is cooled and its volume went from 385 mL to 255 mL. If its final temperature was -55^{o}C, what was its original temperature?

10. What is the mass, in grams, of oxygen in a 20.5 L container at 45.0^{o}C and 2.22 atm?

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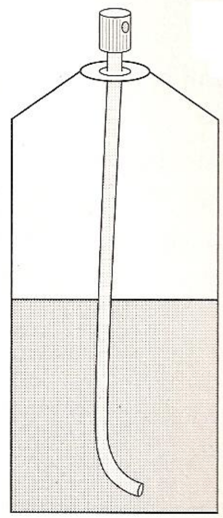
Exploding Containers

Many ordinary products that you use in your home contain a pressurized gas. These products range from hair spray and shaving cream to oven cleaner and spray paint, but they all work in the same way.

The gas is lighter than the liquid and occupies the upper part of the container. The gas exerts pressure on the top of the liquid and on the sides of the can. When you press the push-button to open the valve, the gas pressure forces the liquid up the tube and out through the nozzle. This happens so quickly that the liquid turns into a mist.

Pressurized cans are labeled with warnings to keep them away from heat and to avoid incinerating them when empty. Heating the containers may cause them to explode from too much pressure.

Questions



1. Draw the molecules of gas in this can of hair spray, remembering that they are less dense than the liquid.
2. Use arrows to show the direction of force these gas molecules exert inside the can.
3. When you press the push-button, a valve opens and liquid leaves the can through the tube. How does the gas enable this to happen?

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4. Is the can really empty when no more hair spray is released? Draw a can that reflects your answer next to the diagram above.

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5. Pressurized cans are labeled with warnings to keep them away from heat. How would you change your drawing to show the results of heating the can?

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Gas Laws

Can you answer these questions using concepts from chapter 11?

Why does the volume of this balloon decrease when placed in liquid nitrogen?

Boyle's Law

How does a Cartesian diver reflect Boyle's Law?

Charles' Law

How does a hot air balloon reflect Charles' Law?

Gay-Lussac's Law

How does the popping of popcorn reflect Gay-Lussac's Law?

What law(s) are reflected here?

What law(s) are reflected here?